Film Capacitors – PFC

Installation and maintenance instructions for PFC capacitors

Series/Type:	**PhaseCap Premium, PhaseCap HD, PhaseCap Compact, PhiCap**
Ordering code:	**B25667C / B25669 / B25673 / B32344E**
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Version:	1

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Installation and maintenance instructions

Read this first!	Read the following »Installation and Maintenance Instructions« carefully before installing a capacitor into your application.
About this manual	The information stated in this manual applies to typical, approved usage. Please refer to our product specifications, or request our approval for your own individual specifications, before installing capacitors.
For your safety!	Disregarding the guidelines in this manual can result in operational failure, bursting and fire. In case of doubt, contact your local EPCOS sales organization or distributor for assistance.
General safety notes for installation and operation	■ Ensure you are using the right capacitor type for your application. Please refer to the EPCOS product catalog and application notes for proper selection of capacitors. Please contact EPCOS for any assistance required in selection. ■ Maintain good, effective grounding of capacitor enclosures. ■ Provide the means to isolate any faulty units/banks in the system. ■ Handle capacitor units carefully, as they may be charged even after disconnection due to faulty discharging devices. ■ Follow proper engineering practices. ■ Do not use the HRC fuses to power up and down the capacitor (otherwise this could lead to the risk of electrical arcing!). ■ Also consider terminals of capacitors, connected bus bars and cables and any other devices which are connected with them, as being energized. The device is electrically charged!
Storage and operation conditions	Do not use or store capacitors in a corrosive atmosphere, especially where chloride gas, sulfide gas, acid, alkali, salt or similar substances are present. In a dusty environment, regular maintenance and cleaning, especially of the terminals, is required to avoid a conductive path between phases and/or phases and ground.
Ambient temperature	The ambient temperature category for most standard types is –40/D. This means a max. temperature of 55 °C, an average temperature over 24 hours of 45 °C, and the average temperature in one year should not exceed 35 °C. The maximum casing temperature of 60 °C must not be exceeded. Temperature is one of the main stress factors for polypropylene type capacitors. Temperature has a major influence on the useful life expectancy of the capacitor. For higher temperature requirements, EPCOS offers MKV type capacitors for ambient temperatures of up to 70 °C (with natural cooling).
Caution!	Exceeding the maximum allowed temperature may set the safety device out of operation. Capacitors should not be used any longer in case of dents, mechanical or any other kind of damage! Check the integrity of discharge resistors before installation.

Installation

Mounting the capacitors

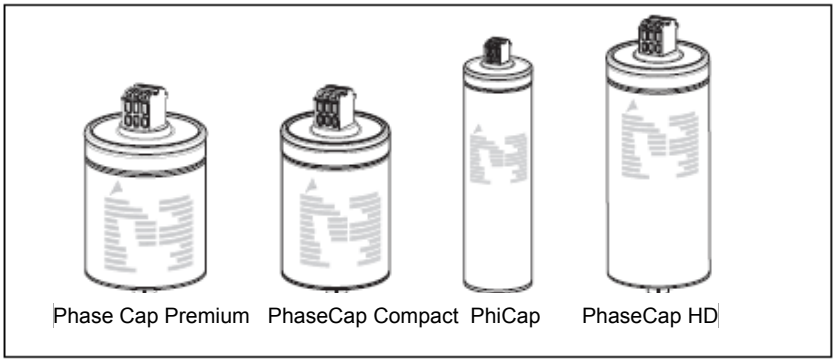


Figure 1: Capacitor overview

Mounting positions

Capacitors installed in a cabinet should be placed on the bottom to ensure the lowest stress temperature possible.

Warning!	Do not install the capacitor in case of dents deeper than 0.5 mm!

PhaseCap Premium, PhaseCap Compact

The PhaseCap Premium and PhaseCap Compact capacitor series may be mounted in the vertical or horizontal position:

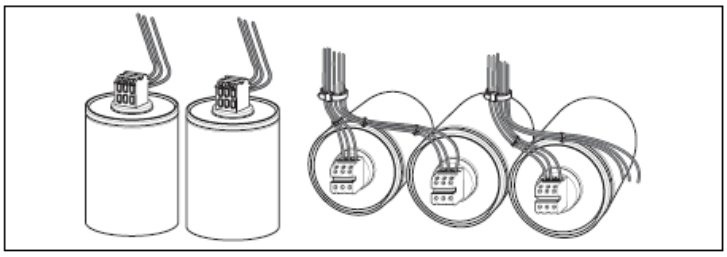


Figure 2: PhaseCap Premium and PhaseCap Compact in vertical or horizontal mounting position

PhaseCap HD, PhiCap

The PhaseCap HD and PhiCap capacitors series may be mounted only in the vertical position:

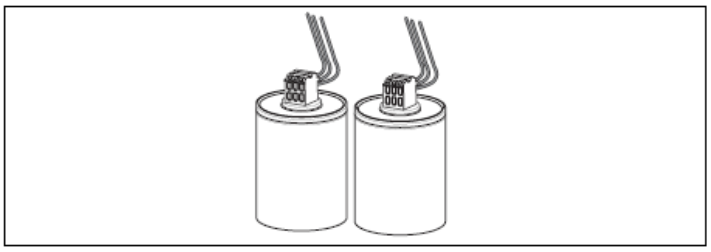


Figure 3: PhaseCap HD and PhiCap in vertical mounting position

Mounting conditions

PFC capacitors must be installed in a cool and well ventilated place, and not close to objects that radiate heat such as filter circuit reactors and furnaces, or in the direct sunlight.

Cooling space for capacitors

Make sure that sufficient cooling space is provided (see Figure 4):

- A minimum distance of 20 mm between the capacitors is necessary to maintain sufficient cooling.
- Keep at least 20 mm space above the capacitor and do not attach any mounting components at the crimp or on top. This gap will allow a longitudinal extension of the can in order to ensure that the over-pressure disconnector can fully extend.

Figure 4: Minimum space over and between the capacitors

Using reactors: cooling space for cables

If reactors are used in an application, note that they operate at a much higher temperature. The distance between the reactor and capacitor must be large enough so that no reactor heat is conducted via the connection cable to the capacitor, or that heat radiation from the reactor to the capacitor causes overheating.

Fixing threaded bottom stud

The threaded mounting stud is at the bottom of the capacitor:

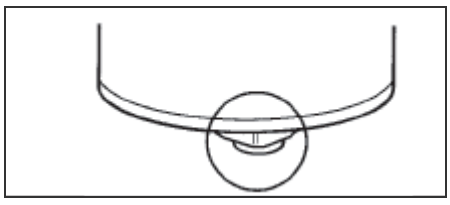


Figure 5: Mounting stud

Fixing

The threaded bottom stud must be fastened with certain specified torques:

- PhaseCap Premium, PhaseCap Compact, PhaseCap HD:
  M12 bottom stud: torque 10 Nm.
- PhiCap:
  M12 bottom stud for diameters > 53 mm: torque 10 Nm
  M 8 bottom stud for diameters ≤ 53 mm: torque 4 Nm

Grounding

The M12/M8 bottom stud is used for grounding. Connect it to the ground by cable, or connect the capacitor to any other conductive item which is connected to the ground.

Note!

Suitable connectors have to penetrate existing layers of lacquer to ensure good, constant conductivity and sufficient current carrying capabilities.

If grounding is done via the metal chassis the capacitor is mounted to, then the layer of varnish beneath the washer and nut should be removed.

Connecting

When connecting, avoid bending cable lugs or cables, or the use of other forms of mechanical force on the terminals. Otherwise, leakage could disable the safety device!

Ensure firm fixing of terminals, fixing torque to be applied as per individual specification.

In any case, the maximum specified terminal current may not be exceeded. Please refer to the technical data of the specific series.

Parallel connection of capacitors via the terminal is not recommended.

Connecting the supply cable

Cable specification

The connection cable must be of flexible type, material should preferably be copper.

Note!

Do not use solid core cables!

Maximum cable cross section is for

- PhaseCap Premium: 25 mm^2
- PhiCap: 16 mm^2
- PhaseCap Compact:
  Capacitor diameter ≤ 85 mm: 16 mm^2
  Capacitor diameter > 85 mm: 25 mm^2
- PhaseCap HD: 35 mm^2

Further information can be found in the Appendix.

The connection cables to the capacitor should be dimensioned for a current of at least 1.5 times the rated current so that no heat is conducted into the capacitor.

Maximum terminal currents

Do not exceed the maximum allowable current:

- PhaseCap Premium: Max. 80 A total RMS current
- PhaseCap Compact:
  Capacitor diameter ≤ 85 mm: Max. 50 A
  Capacitor diameter > 85 mm: Max. 80 A
- PhaseCap HD: Max. 130 A total RMS current
- PhiCap: Max. 50 A total RMS current

Attaching the supply cable

Attach the supply cable only with the maximum permissible torque values:

- PhaseCap Premium: 2.0 Nm
- PhaseCap Compact:
  Capacitor diameter ≤ 85 mm: 1.2 Nm
  Capacitor diameter > 85 mm: 2.0 Nm
- PhaseCap HD: 2.5 Nm
- PhiCap: 1.2 Nm

Screw driver

Use an appropriate screw driver.

PhaseCap Premium, PhiCap and PhaseCap Compact:
5.5 x 1/Ph2/Pz2 type

PhaseCap HD: DIN 5264-B 1.2 x 6.5

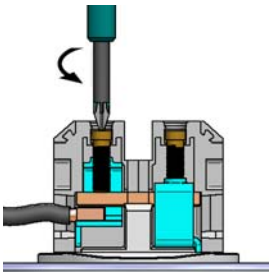


Figure 6: Fixing the supply cable

Using discharge resistors

Discharge resistors are included in the delivery package, pre-mounted by the factory for PhaseCap, PhaseCap Compact and PhiCap E-series. Capacitors with voltage from 765 V onwards and all PhaseCap HD-types are provided with external discharge module (see figure 7 on the next page).

Discharge resistors are required for discharging of capacitors to protect operating personal (risk of electric shock hazard) and for re-switching capacitors in automatic PFC equipment (phase opposition!).

EPCOS discharge resistors are designed to discharge capacitors down to 75 V or less within 60 seconds (some types within 90 seconds; please refer to the specific data sheet).

Make sure that the correct resistor is used for replacement, e.g. ohmic value and push-on connector diameter.

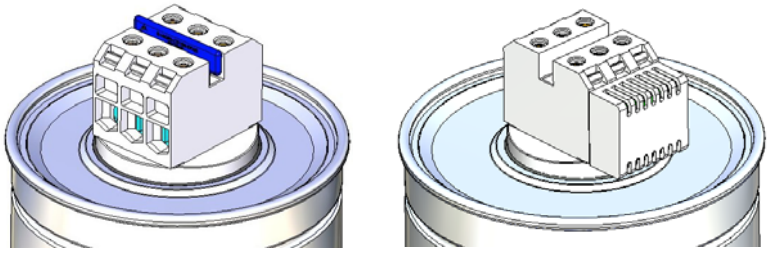
Discharge the capacitor

Before re-switching, capacitors must be discharged to 10% of the rated voltage or below.

A discharge resistor can be easily replaced by pushing it onto the exposed top on the terminal.

Caution!

Discharge and short circuit the capacitor before handling!



Push on discharge resistors External discharge resistor

Figure 7: Discharge resistor and discharge module

Inrush current limitation

Switching LV PFC capacitors can cause high inrush currents of more than 200 times the rated current, especially when they are connected in parallel to others that are already energized. This may cause additional stress to contactors as well as to capacitors and reduce their life cycle.

Inrush currents have a negative effect on power quality, e.g. transients, voltage drop. MKK- and MKP-designs feature high impulse handling capability, inrush current limitation is required, e.g. contactors with pre-charging resistors for pre-loading of capacitors.

IEC 60831 Standard and Reference

According to the IEC 60831 standard, following maximum switching operations per year are acceptable:

PhaseCap Premium,	
PhaseCap HD and PhiCap	5000 switching operations
PhaseCap Compact	10000 switching operations

Before considering a higher number of switching operations, please contact EPCOS.

Harmonics

Harmonics are voltages and currents with frequencies that are different from a 50 Hz or 60 Hz power supply frequency.

Harmonics result from the operation of electrical loads with non-linear voltage-current characteristics.

They are mainly caused by loads operated with modern electronic devices, such as converters, electrical drives, welding machines and uninterruptible power supplies (UPS).

Ensure that the current through the capacitor doesn't exceed 1.5 … 2.0 • I_R for PhaseCap Premium, PhaseCap HD and PhiCap. For PhaseCap Compact the maximum limit is 1.6 … 2.0 • I_R. This may indicate heavy presence of harmonics. Check the voltage and current using a true RMS multi-meter.

Ensure that the voltage doesn't exceed 1.1 • V_R and the peak voltage doesn't exceed 1.6 • V_R. Use a true rms and peak voltmeter or oscilloscope to check it.

Installation and maintenance instructions for PFC capacitors

Attention!	Only power capacitors with reactors – namely de-tuned capacitor banks – should be used in applications with harmonic distortion. Depending on the chosen series resonance frequency, a part of the harmonic current will be absorbed by the power capacitor. The rest of the harmonic current will flow into the grid. The use of power capacitors with reactors reduces harmonic distortion and minimizes the disturbing effects on operation of other loads.
Avoid resonance conditions	The most important reason for installing de-tuned capacitor banks is to avoid resonance conditions. Resonance conditions may multiply existing harmonics, create power quality problems and damage distribution equipment. Occurrences of resonance should by all means be avoided by appropriate application design! Total RMS capacitor current (incl. fundamental and harmonic currents) specified in the technical data of the specific series must never be exceeded.
Overpressure Disconnector	Electrical components do not have unlimited life expectancies; this also applies to self-healing capacitors. As polypropylene-type capacitors seldom produce a pronounced short circuit, HRC fuses or circuit breakers alone do not offer sufficient protection. All capacitors of the PhaseCap Premium, PhaseCap Compact, PhaseCap HD and PhiCap series are consequently fitted with a disconnector that responds to overpressure. If numerous electric breakdowns occur at the end of life or as the result of thermal or electric overload (within IEC 60831 specification), the formation of gas causes the pressure inside the capacitor case to rise. This causes a change in length because of curvature of the lid or stretching of the expansion bead. Expansion beyond a certain degree will separate the internal wires (tear-off fuses) and disconnect the capacitor from the line.
Caution!	To ensure full functionality of an overpressure disconnector, observe the following requirements: 1) The elastic metal top must not be impaired: ■ The connecting lines must be flexible leads (cables). ■ There must be sufficient space for expansion above the connections (stated for the different models). ■ The folding groove must not be retained by clamps. 2) The maximum allowed fault current of 10000 A to the UL 810-standard must not be exceeded. 3) Stress parameters of the capacitor must be within the IEC 60831specification.

Overcurrent / short circuit protection	HRC fuses or moulded case circuit breakers for short circuit protection have to be used. Short circuit protection equipment and connection cable should be dimensioned to handle the 1.5 times rated current of the capacitor permanently. ■ HRC fuses do not protect the capacitor against overload. They are only a short circuit protection! ■ HRC fuse rating has to be 1.6 ... 1.8 times nominal capacitor current. ■ Do not use HRC fuses for switching capacitors (lightning arc!). ■ Use thermal/magnetic overcurrent relays for overload protection.

Maintenance

Caution!	Disregarding the following measures may result in severe operation failures, bursting and fire. ■ Check tightness of the connections/terminals periodically, two weeks after installation at the latest, and then once every month. ■ Clean the terminals/bushings periodically to avoid short circuits due dust or other contamination. ■ Check the short circuit protection fuses. ■ Take current reading twice a year and compare with nominal current. Use a harmonic analyzer or true effective RMS-meter. ■ In case of a current above the nominal current check your application for modifications. ■ If a significant increase in the amount of non-linear loads is detected, a consultant has to be called in for a harmonic study. ■ In cases of the presence of harmonics, the installation of a de-tuned capacitor bank (reactors) must be considered. ■ Check the discharge resistors/reactors and in case of doubt check their function: (1) Power the capacitor up and down. (2) After 60 seconds the voltage between the terminals must decline to less than 75 V. Please note that for specific types discharge time is 90 seconds! ■ Check the temperature of energized capacitors. In case of excessive temperature of individual capacitors, it is recommended to replace this capacitor, as this could be an indication for loss factor increase which is a sign for reaching end of life.
Note!	For detailed information about PFC capacitors and cautions, refer to the latest version of EPCOS PFC Product Profile. Please note again that these »Installation and Maintenance Instructions« apply to typical specifications. Refer to our product specifications, or request our approval for your specification before installing a capacitor

Appendix

Connection cable cross section, HRC fuse rating

Listed below are recommendations to VDE 0100 for fusing and cable cross sections for three phase power capacitors.

VDE 0100 recommendations

Cross-section values mentioned below are guideline values valid for operation under normal conditions and at an ambient temperature of 40 °C. Higher values should be selected if conditions differ from the norm, such as higher temperatures or harmonic distortion.

kvar rating at 400 V kvar	Nominal current A	HRC fuse rating A	Cross section of supply cable mm^2
5	7.4	16	1.5
6.3	9	16	2.5
7.5	10.8	20	2.5
8.3	12	20	2,5
10	14.4	25	4
12.5	18	35	4
15	21.6	35	6
20	29	50	10
25	36	63	16
30	43	80	25
40	58	100	35
50	72	125	35

For other voltage ratings:

230 V table figure • 1.74

440 V table figure • 0.91

480 V table figure • 0.83

525 V table figure • 0.76

690 V table figure • 0.58

800 V table figure • 0.50

The internal wiring of a capacitor bank can be normally done with a lower cross section. Various parameters such as temperature inside cabinet, quality of cable, maximum cable isolation temperature, single or multi-core cable and length of cable have to be taken into consideration when selecting the appropriate value.

Vibration resistance

The capacitor resistance to vibration corresponds to IEC 68, part 2-6. The following values apply to the capacitor alone.

Test Conditions

Max. test conditions:

■ Test duration	2 h	
■ Frequency range	10 ... 55 Hz	max. 0.7 g
■ Displacement amplitude	0.75 mm	

The connections and the terminals may influence the vibration properties. It is necessary to check the stability when an installed capacitor is exposed to vibration. Irrespective of this, it is not advised to locate capacitors where vibration amplitude could reach maximum levels in strongly vibrating appliances.

Note

For detailed information about PFC capacitors and cautions, refer to the latest version of the EPCOS PFC Product Profile.

Important notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application.** As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified.** In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or life-saving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
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